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A REVIEW OF EPA'S DECISION UNDER THE SUPERFUND PROGRAM FOR AN ONSITE CLEANUP OF THE LIPARI LANDFILL

SUMMARY

EPA has selected an admittedly unproven remedy for this site. Although trying new cleanup approaches is necessary if the Superfund program is to advance technically, EPA's contractor study articulates numerous technical concerns and uncertainties about the flushing approach chosen for the Lipari site. Moving directly from a limited laboratory experiment to a full-scale cleanup raises concerns. Demonstrating a new technology may best be done under a formal technology demonstration program, rather than by conducting a full-scale cleanup. OTA notes that a similar Superfund site is being cleaned with a flushing approach, but this experience, although limited, has apparently been ignored in evaluating approaches to Lipari; indeed its existence is not mentioned. A recent decision on another site considered the use of soil flushing, but rejected it.

On the other hand, EPA and its contractor rejected excavation of the contaminated soil even though the technology was stated to be effective and reliable; high costs and difficulty in implementation were cited as reasons for rejection. OTA finds insufficient detail to substantiate the costs for the removal option. Moreover, no consideration was given to technical variants of the excavation option, in particular: (1) partial excavation of the site (which has been done elsewhere) combined with flushing; (2) ways to mitigate the risks

and difficulties of excavating a site where toxic gases are likely to be emitted (e.g., enhanced volatilization and treatment of organics, recently selected for another Superfund site); or (3) excavation followed by treatment of the contaminated soil rather than by transport to a landfill.

OTA has conceptualized a remedy consisting of three complementary means of addressing the health and environmental threats of the contamination at Lipari. The approach consists of: (1) dewatering, enhanced volatilization of toxic organic chemicals which are already leaking from the site, and sampling and testing to determine the distribution of contamination (as has been done at other sites); (2) removal of soil from portions of the site based on the results from (1) followed by incineration of the contaminated soil and chemical treatment of the residue; and (3) limited flushing of the site. This approach is likely to take far less time than the 15 years estimated for the chosen remedy, which has little assurance of reaching an acceptable end-point. The costs might total to about $65 million - that is, several times more than the roughly $10 million for the chosen remedy (not all the future costs are included in the $10 million figure), but much less than the $290 million cited for total removal.

INTRODUCTION

This analysis is strictly for the onsite cleanup at Lipari. OTA has not examined what is referred to as offsite cleanup, but it recognizes that the offsite cleanup is just as important as the onsite one and that expedient and effective onsite cleanup is necessary to avoid further offsite contamination. This examination of the onsite cleanup is based on a review of three documents

on the Lipari Landfill, New Jersey, a site on the National Priorities List of the Superfund program:

1. "Record of Decision - Remedial Alternative Selection," EPA, September 30, 1985. (hereafter referred to as ROD)
2. "Final Responsiveness Summary for the On-Site Remedial Investigation and Feasibility Study," EPA. (hereafter referred to as RS)
3. "Final Draft Report - Onsite Feasibility Study for Lipari Landfill," Camp Dresser & McKee Inc., August, 1985. (hereafter referred to as FS)

The purpose of this brief review is to evaluate the decision and its supporting analyses and documentation for the onsite cleanup of the Lipari Superfund site. Key questions addressed include the following: (1) Is the selected remedy likely to be effective environmentally and is it consistent with the statutory mandate to select the cost-effective remedy? (2) Was the analysis of alternative remedies technically sound? (3) Is there some remedy which has not been considered and which might be more effective than the chosen remedy?

THE CHOSEN REMEDY

EPA has made the following comments about the chosen remedy of groundwater/leachate collection and treatment followed by cycles of batch flushing and collection to remove water soluble contaminants:

"The flushing operation will achieve the reduction of contaminants in the containment system to the limits of its technology." ROD, p.2

"...the actual reduction in contaminants during flushing operation is unknown..." ROD, p. 25

"...it is impossible to determine how clean the groundwater would be at a given time... ...the groundwater in the landfill will probably never meet all applicable or relevant standards." ROD, p. 28

"Flushing, as it relates to the LiPari site, is an unproven technology. That is, this technology has not been demonstrated to be effective under similar operating conditions to those found at Lipari; hence the reliability of this technology is questionable." ROD, Table 8 (Note that EPA rejected the use of in situ biological processes "because the technology is unproven for situations like the LiPari Landfill site." RS, p. 10)

"EPA stressed that it is necessary to try flushing or it will always remain an unproven technology." RS, p. 8

"It is impossible to estimate the percentage [of contamination] that will be left after flushing." RS, 9

The results of a 1981 laboratory experiment were cited as an important basis for evaluating and choosing the batch flushing option. The experiment found that about 90 percent of the water-transportable contamination could be flushed after an exchange of 10 pore volumes of clean water. But only a few contaminants were tested for and no analysis seems to have been performed on the broad range of contaminants using basic scientific data to estimate the potential effectiveness of soil flushing (i.e., soil/water or other partition coefficients).

This experiment was conducted, moreover, on a sample of the Lower Cohansey, a layer of sand about 10 feet in thickness with much less permeability than the Upper Cohansey region, roughly 25 feet in thickness, through which the flushing and withdrawal will take place. There is little information given in the FS about the physical differences between these two strata; apparently no other tests of the performance of flushing for soil decontamination have been conducted for this site, even though many other tests have been performed at the site. However, substantial differences in permeability would normally be associated with factors, such as pore morphology, that would also affect flushing performance. Thus all estimates of the effectiveness of the selected remedy are based primarily on one limited laboratory experiment on soil different from that to be flushed. The contractor recognized this point as follows: "However, concern is raised that this laboratory experiment using a sample from the Lower Cohansey may not be applicable to field conditions actually encountered." (FS p. 4-48)

EPA's contractor noted that "reinjection of 10 pore volumes into the containment system is utilized herein for cost estimating purposes only." (FS p. 4-9) However, EPA in its ROD justifies its selection of flushing by saying that "Ninety percent of the water-transportable contaminants can be removed..." and that "The operating duration of the flushing program at the landfill is estimted to be ten to fifteen years shorter than other alternatives." (ROD, p. 26) This illustrates how important and carefully worded caveats provided by a contractor can disappear during the decision-making process. Such statements by EPA are contradicted by other statements it makes in the ROD about the extent of remedy. EPA admits that it cannot now know how long flushing will have to go on. With regard to the issue of "How clean is clean?" the cleanup for Lipari appears very open-ended. EPA says that the flushing may not work or may be found to be yielding few benefits and, therefore, that some other action may be necessary.

OTA concludes that little confidence can be placed on the extremely limited information now available in judging the effectiveness of the flushing approach or in estimating costs of effective treatment. This means that a comparison of costs between flushing and other alternatives needs to be heavily qualified to avoid being misleading. There is every reason to believe - and EPA admits - that a 10 pore volume flush will not result in acceptable levels of residual contamination. In fact, the contractor notes: "Of importance is the fact that even at 99.9% removal of the contaminant concentration (if this could ever be achieved) the entire array of potential remediation criteria could not be met." (FS p. 4-38) Specifically, excessive discharge of bis-(2-chloroethyl)ether to surface waters of Alcyon Lake associated with the flushing cleanup is noted by

the contractor, with amounts likely to be about 14 to 16 times greater than the Federal criteria (assuming 90% removal). (FS p. 4-95) That is, the chosen flushing remedy is acknowledged to be incapable of meeting cleanup goals. Nevertheless, it was one of the three alternatives recommended by the contractor.

The issue is not whether an innovative cleanup technology can be used in a Superfund cleanup. Rather, it is whether a sufficient case is made for its use. Later in this review, OTA supports consideration of an innovative technology (i.e., enhanced volatilization) for which there is more information to support its use. The proposed use of flushing in the Lipari cleanup, in effect, is based on a single, not necessarily applicable laboratory experiment that leapfrogs duplicate experiments, pilot studies and field demonstration. That is, the $10 million cleanup is itself a demonstration experiment without the preliminary work normally required to justify and plan such a demonstration. The question can be asked: Why has no other laboratory or pilot work been started during the past several years on the ability to use flushing to decontaminate the Lipari site? Although the FS suggests the need to do this during the subsequent Remedial Design phase, it makes more sense to do it before the ROD is issued and while the public still has a chance to comment on the recommended cleanup method. Moreover, EPA's "Guidance on Feasibility Studies Under CERCLA" (April, 1985) directs those who prepare an FS: "In evaluating remedial alternatives, the user should be sensitive to public perception of the alternatives. Alternatives perceived to be unacceptable by the community may be delayed or prohibited by zoning changes or other measures." (p. 4-15) In this

regard, in the evaluation of the flushing method, no mention was made of any disadvantage that this particular unproven technology poses for use at Lipari.

A related problem concerns the position of EPA and its contractor that the flushing alternative is new and innovative; this is not completely accurate. A similar flushing cleanup has been selected for another Superfund site with similar characteristics and problems; this is the Sylvester site in Nashua, New Hampshire. However, no mention of this site or its cleanup exists in any of the critical documents for Lipari. Before using flushing on a large scale, it would seem prudent for EPA to examine the design, progress, and effectiveness of the cleanup at Sylvester, especially in view of the fact that so much attention is given in the ROD and FS about the untested nature of the flushing approach for Lipari. Note that the major contractor for Sylvester (Roy F. Weston, Inc.) is also a subcontractor to CDM.

The Lipari contractor has cited several disadvantages with the selected remedy (FS pp. 4-49-59), with which OTA is in agreement:

"The technology has not been demonstrated under full-scale operating conditions."

"The effectiveness of the flushing cycle cannot be accurately monitored."

"Residual contamination bound to the encapsulated soil matrix and not presently removable by hydraulic flushing might be released and become water transportable at some future time due to changes in the soil micro-environment, e.g. in pH, redox potential, or due to biological activity."

"Because the retention mechanisms between the soil and the contaminants is not known, the effectiveness of flushing in cleansing the site cannot be predicted."

"The implementability of flushing scenarios must be viewed cautiously with regard to operation and maintenance requirements. Clogging and corrosion of the injection wells are major technical considerations."

The contractor also noted that the initial laboratory experiment "did not account for any contamination adsorbed onto the soil particles which hence could not be removed by hydraulic flushing." (FS p. 4-102) In other words, some significant contamination might remain in the soil after flushing. This should serve as a warning not to make premature decisions on what constitutes a final cleanup or, more importantly, about future use of the site even if monitoring shows no water contamination onsite or offsite after flushing.

EPA also should worry about the movement of contaminated water out of the site during or after the batch flushing cleanup. The contractor has noted that this approach will result in gradients out of the slurry wall containment system during some periods. An outward gradient will be even more significant if the permeability of the containment wall should degrade over time, a possibility of

concern to the contractor. In its ROD, EPA does not indicate a means to deal with this problem, although it does commit funds for monitoring the release of contaminated water through downward vertical seepage (within the containment wall) and recognizes that some remedial action may be necessary to deal with vertical and then lateral routes of release through the aquifer and finally to the nearby lake. (OTA has not focused on this problem; however it should be noted that EPA decided not to pump the Kirkwood sands and remove vertical seepage. Unless an effective onsite cleanup is completed relatively quickly this could be a serious omission, as contaminants may migrate offsite. Moreover, EPA's decision is in conflict with what its contractor said, namely that all of the alternatives it was recommending would include pumping of the Kirkwood sands.)

Consequently, the estimated cost of the selected remedy ($8.9 million) does not account for possible future spending because of: (a) contamination outside the containment wall caused by the cleanup; (b) mitigation of releases resulting from vertical seepage not addressed by the cleanup; and (c) future actions to deal with possibly unacceptably high levels of residual contamination in water reaching surface waters, due to the limits of flushing. Thus, eventual cleanup costs could exceed $8.9 million. The degree of uncertainty about the technical effectiveness of the selected remedy is matched by the uncertainty of its costs; both are high. The analysis of costs by CDM suffers from the omission of a sensitivity analysis which EPA's guidance for FS preparation says should be included. Because of the considerable differences in the nature of the cleanup options examined (e.g., proportion of capital to operating and maintenance

costs, uncertainty of extent of cleanup, and effective life of remedial action), such a sensitivity analysis of factors, such as discount rate, whose variations can have large effects on total costs, is particularly called for.

THE REJECTED OPTION OF SOURCE REMOVAL

One of the alternatives considered in the FS was termed the Complete Removal option. It was defined as dewatering followed by excavation of the contaminated soil, refuse and miscellaneous bulk material for transport to a commercial landfill and subsequent restoration of the site. The FS and ROD term this option "Most reliable of alternatives in terms of source control." (ROD, Table 8) The contractor says: "This alternative would be the most reliable of all the alternatives under consideration in terms of removal or control of the source of onsite contamination (and subsequent offsite contamination). The technologies necessary to implement this alternative...are proven and have been demonstrated to be effective." (FS pp. 4-41, 4-43) However, the FS also presents a strong argument for not using this alternative because of problems and risks arising from emissions of volatile toxic chemicals during excavation. Problems and risks associated with transportation of large amounts of material to a landfill are also cited. However, it seems clear that the $290 million cost estimated by the contractor was a major reason for rejecting the option: "Alternative 1 (Complete Removal) proved to be the most costly alternative at between 2 and 3 orders of magnitude above the cost of the other alternatives. Alternative 1 was therefore considered to be an unfeasible alternative." (FS p.

xiii) and "...the Complete Removal alternative...is not feasible from a cost viewpoint." (FS p. 4-100)

In its RS, EPA makes an argument for its rejection of the complete removal option that is not consistent with the statutory mandate of selecting the cost-effective remedy. EPA invokes a somewhat different basis of selection by saying that it used a "cost-benefit determination that first considers the technical feasibility and environmental effectiveness of the site remedy and then compares costs and benefits among those alternatives that meet this effectiveness criteria. In the case of the LiPari Landfill site, the cost for Alternative 1 are significantly higher than other effective options." (RS p.4) The FS does not include a detailed or quantitative evaluation of benefits for the alternatives, nor is the CERCLA statute a cost-benefit type (as are some other environmental statutes). Moreover, as indicated above, the selected remedy cannot be said to offer environmental effectiveness but the complete removal one does, if one considers the cleanup only narrowly and ignores what happens to the excavated material. Thus, OTA does not agree that both the flushing and complete removal options offer comparable, effective levels of environmental protection (or benefits) and, therefore, it cannot be said that the selected remedy is more cost-effective than the complete removal option.

In its ROD, EPA cites factors other than the high cost in its explanation of why this opton was rejected; these are: risks associated with implementation, inherent difficulties of such a large-scale operation, and the scarcity of secure RCRA-permitted landfills that could and would accept about 864,000 cubic yards of hazardous materials.

OTA finds a number of problems with the analysis in the FS. First, there is no detailed cost information on the excavation and land disposal parts of this option. The only figure given is $212.3 million for soil excavation and disposal. This is highly unusual in terms of what is normally presented in an FS; indeed, there is considerably more detail provided for every other alternative. One would expect, for example, to find unit cost data from commercial landfill operators, mileage figures for transportation costs, and costs for excavation and site restoration. There is no documented basis for the total, high cost figure for this alternative. Nor is there any detail to support the EPA contention that a permitted landfill could not be found for this job. (Note, however, that OTA does not find removal for redisposal a satisfactory option, for reasons detailed in its SUPERFUND STRATEGY report; see, for example, pages 12-17, 18-20, and 125-159.)

OTA is also concerned about the scanty analysis in the FS on the technical problems caused by volatilization of toxic chemicals during excavation and transportation and, more importantly, on engineering ways to mitigate such problems. There is no doubt that excavation at Lipari presents health problems for onsite workers and the surrounding community. But these problems are not, a priori, obviously insoluble. Moreover, at least one problem might be overstated. Although transportation of hazardous materials does pose known risks, CDM used statistical data for transport of all forms of hazardous materials, and not just waste. There is some reason to believe that the safety record for transport of hazardous waste is better than for transport of hazardous chemical commodities.

Several engineering approaches to the implementation problems might have been considered in the FS, but were not. For example, incremental excavation across the area might make gas emissions easier to control, but this technique was not analyzed. Nor is there a comparison of the current level of escape of volatile organics (which are not now collected) relative to that expected with excavation. Furthermore, might some form of enhanced volatilization and treatment of the captured gases be used after dewatering and prior to excavation?

In August, EPA issued a ROD for a site in Michigan (Verona Well Field, Battle Creek) in which an enhanced volatilization method is to be used for soil contaminated with volatile organic compounds. (A flushing option, which was considered innovative, was not selected, mainly because of longer times to achieve equivalent results.) A previous field test had provided some basis for using what was acknowledged to be an innovative cleanup approach. Although site conditions are different, the principle of using vacuum to extract volatile gases was demonstrated at a site in California; this represents a more substantial effort than the single laboratory test cited to support the efficacy of soil flushing. To support its decision in Michigan, EPA has said: "The enhanced volatilization process has been used successfully in a number of hazardous waste applications... Terra Vac, Inc., one of the firms developing this new technology has reported the recovery of carbon tetrachloride, methylene chloride, hexane, acetone, methanol and gasoline in a variety of hydrogeological settings." (Community Relations Responsiveness Summary for Verona Well Field, August, 1985) Moreover, the gas extraction method is relatively inexpensive.

This illustrates the serious problems with information transfer within the Superfund program. The enhanced volatilization method was described in the June, 1985 FS performed by another of EPA's prime Superfund contractors (CH2MHill) and the pilot work which formed the basis for the analysis and recommendation was done by one of the subcontractors for Lipari (Woodward-Clyde Consultants and reported in February, 1984). If EPA can approve an unproven flushing approach which it recognizes as of highly uncertain effectiveness (without, as noted above, examining the albeit limited experiences from a similar site), why not at least consider another technique with which there is some field experience? Enhanced volatilization, although it would not remove all water soluble contaminants from Lipari, when coupled with partial excavation would reduce the burden put on subsequent flushing.

Moreover, there was no consideration of partial excavation based on sampling and analysis of the site soil to determine exactly what needs to be removed; this has been done for a number of other Superfund sites. It is recognized that only a small portion of a landfill site may have to be excavated in a cleanup; for example, only about 6 acres of the total 15 acre Lipari site was used originally as a landfill. Also, enough is known about the movement of the underground water to estimate what parts of the site area might be highly contaminated. It is not clear to OTA whether some useful information about the distribution of site contamination may have already been obtained. It should be possible to establish criteria for certain key contaminants so that areas with higher concentrations can be designated for excavation. In this way the fraction of contaminants removed can be much greater than the fraction of soil excavated.

The contractor did not consider onsite or offsite treatment, such as incineration, of the excavated material; transport to a commercial landfill was the only post-excavation option examined. Transporting large amounts of material over long distances can be extremely costly compared to onsite destruction or detoxification. It is common, for example, to have transportation costs that far exceed costs for landfilling.

To sum up, OTA finds that a very high, but unsubstantiated cost estimate for an unimaginative form of excavation and redisposal without consideration of various technical possibilities explains why excavation was rejected by EPA and its contractor. In the next section, OTA presents a conceptual remedial possibility that could resolve some of the legitimate problems posed by EPA and its contractor, and that also might be more cost-effective.

A POSSIBLE CLEANUP APPROACH

A remedy that would combine the advantages of the complete removal and batch flushing alternatives considered by EPA would consist of (a) a dewatering step followed by (b) enhanced volatilization, (c) partial excavation of contaminated materials, (d) backfilling of clean(ed) soil, (e) onsite treatment of the contaminated materials, and (f) flushing. The residue from (e) could be landfilled as a normal solid waste or used as the backfill material. Far less flushing would be necessary than in the selected remedy because most of the contaminated soil and waste would have been removed and treated. In effect, this approach has some fail-safe features as compared to relying solely on flushing.

Partial excavation reduces costs and risks from volatile organics; it is a proven approach for cleanups. Put another way, to reduce costs while maximizing environmental effectiveness, use is made of both excavation and flushing. It should be possible to devise ways, as suggested above, to deal with the problem of volatile organics during excavation rather than view it as an insurmountable obstacle. Onsite treatment of the excavated material eliminates large transportation costs and is more acceptable environmentally from a total system perspective (i.e., not using the toxic waste merry-go-round approach).

One treatment scenario would be an onsite mobile incinerator, with costs of perhaps $150 per cubic yard (a newly available technology from Shirco Infrared Systems of Dallas, Texas offers such low costs and it has been demonstrated in Missouri for safely and effectively treating dioxin contaminated soil), followed by a low cost chemical treatment of the residue to immobilize residual toxic metals (one possibility discussed in OTA's Superfund Strategy report is a product from Lopat Industries of Wanamassa, NJ). Delisting the treated residue as a hazardous waste (which is within the power of EPA) would allow transport to a closer and less costly solid waste landfill. Or it could be used for backfill and all disposal and transportation costs could be eliminated. In any event, the appropriate course to pursue for this approach would be to expedite tests on materials from Lipari to ascertain the effectiveness of treatment technologies.

In its RS, EPA cited a cost of $12.7 million for partial excavation and onsite storage, an option not considered in the FS by the contractor. OTA does not see why onsite storage is necessary, because technology now exists to treat the types of contamination existing in the Lipari landfill site. There could be enough time to design and plan for onsite treatment during the earlier phases of

site dewatering, enhanced volatilization, site sampling, and partial excavation.

If onsite treatment were used the costs would be higher, depending on how much material was excavated and treated. For example, if about one-third (only about one-third the area was the original landfill) of the material was excavated (288,000 cubic yards) and the total treatment cost was $200 per cubic yard, the cost would be $58 million, plus costs for enhanced volatilization and some fraction of the cost of the flushing alternative. That is, it might be possible to design a remedy with environmental effectiveness whose costs would be perhaps $65 million and that could be implemented in far less time than the 15 years currently estimated for the highly uncertain and admittedly unreliable batch flushing alternative. It might be possible to implement this approach within about 5 to 7 years.

To sum up, although the above is a rough estimate, OTA's analysis indicates a removal-treatment-flushing cleanup is feasible and could be much less expensive than the $290 million estimated for total excavation and transportation to a landfill. Such an alternative merits examination by EPA. The increase in cost over the $8.9 million for the selected remedy (whose cost might be much greater) might be offset by more reliability, effectiveness, and certainty.